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Development And Characterisation Of Hibiscus Lampas (Adavi Benda) Reinforced Composites

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Abstract: **In recent years natural fibers appears to be the outstanding materials which come as the viable and abundant substitute for the expensive and non-renewable synthetic fiber. Natural fibers like kenaf fiber, oil palm fiber, vegetable fiber, bamboo fiber, jute fiber, sisal fiber, coconut fiber and pineapple leaf fiber, banana, and coir has been used, till now, as a reinforcement in thermoplastic composite for applications in consumer goods, transportation, furniture, low cost housing and civil structures.**

In the proposed work, natural fiber composite Lamina is developed with Hibiscus lampas fiber (ADAVI BENDA).the fibers of ADAVI BENDA plants noted for their high strength toughness weather resistance. They are long, continuous and flexible and naturally bonded together and traditionally being used for light load bearing domestic applications. Observing these features, the ADAVI BENDA fibers have been chosen for fabrication of green composite laminates that can be used for panels construction and various domestic projects, packaging applications sport goods etc.

The laminate is prepared using unsaturated isopthalic polyester resin. In this project, the tensile testing is carried out, as per ASTM standards on universal testing machine. By conducting the test we determined the Ultimate tensile strength.

I. INTRODUCTION

Preliminary remarks

Fiber-reinforced composite materials are an important class of engineering materials that offer outstanding mechanical properties with flexibility in design and ease of fabrication. The advanced composites have the advantages of light weight, corrosion resistance, impact resistance and excellent fatigue strength. Today fiber composites are widely used in diverse applications such as automobiles, aircraft, containers and piping, sporting goods, electronics and appliances. These composites are fabricated using various reinforcing materials like glass fiber, carbon fibers, graphite, kevlar fibers, etc. These fibers are non-biodegradable and offer environmental problems in disposing the scrap. The present trend of development of any technology should comply with the sustainable development and preserve the biodiversity. In view of this global concern, natural fiber reinforced composites are being envisaged that offer least problems to the environment and at the same time offer new and better materials to the society.

The materials and products developed using natural fibers will not only have enhanced properties compared to the conventional thermoplastics or complete wood based products but also will be cost effective. The use of green composite materials is predicted to have tremendous market potential because of the increasing awareness of environmental issues such as biodegradation, renewable resources, CO_2emission reduction through promotion of plantations. The researchers are exploring the application of various natural fibers like sisal, jute, kenaf, palmyra, etc., with polyester and epoxy resins as matrix materials.

Aim and Scope of the Work

The present work is aimed to prepare the laminates using the fibers of Hibiscus lampas Telugu Vernacular name: **AdaviBenda,**botanical name **Thespesia Lampas,** fiberandIsopthalic Polyester Resins are used as the matrix materials. Mechanical properties like tensile, flexural strengths are evaluated as per ASTM standards.

Objectives and Justification of the Project

The objective of the present work is to develop biodegradable composite laminates using natural fibers from ***Thespesialampas,***that belongs to the **MALVACEAE** family and its telugu vernacular name is ***Adavibenda.***

- The aim of this Project is to project the potential of natural fiber composites and promote their production on commercial basis.
- It is aimed to encourage more plantations of trees such as *Adavibenda* that yield fibers and to provide employment in the agriculture and handloom weaving sectors and develop cottage industries in the rural areas.
- The entire activity is aimed to develop new materials for enhanced performance and for the sustainability of the environment for the generations to come.

The *Adavibenda* trees are abundantly found in the forest areas of A.P. the stem yield strong fibers that are traditionally used by the farmers in domestic and agricultural applications. Observing these features, the *hibiscus lampas* fibers have been chosen to produce green composite products that can be used for several applications such as panels in construction, casings for various domestic products, packaging applications, sport goods etc.

Layout of the Report

The second chapter gives an over view of existing literature on natural fiber composites. Third chapter gives a brief summary of synthetic fiber composite materials as well as about natural fiber composites. Chapter four illustrates fabrication methods used for producing laminates. Fifth chapter provides the details of preparing the specimens and testing. Conclusions and scope for the future work are presented in the sixth chapter. References are given at the end.

II. THEORETICAL BACKGROUND

Definition of Composite Material

A composite is a structural material which consists of two or more constituents. These constituents are combined at a macroscopic level and are not soluble in each other. One constituent is called the reinforcing phase and the other is called the matrix.For a material to be composite conditions to be satisfied are: both constituents have to be present in reasonable proportions, composite properties are noticeably different from the properties of the constituents.

Fibers:

A large variety of fibers are available as reinforced for the composite. The desirable characteristics of most reinforcing fibers are high strength, high stiffness and relatively low density. A great majority of materials are strong and stiffer in the fibrous form than as the bulk material. Therefore, fibers are very effective and attractive reinforcement materials. Different reinforcing fibers are glass fibers, carbon and graphite fibers, aramid fibers and natural fibers like jute, sisal, flax, screw pine etc.

Matrix:

The matrix serves to bind the fibers together and transfer loads to the fibers and protects them against environmental attack and damage due to handling. Matrix has strong influence on the mechanical properties as well as on the selection of fabrication process. Polyester and epoxy resins are the most common polymeric matrix materials used with high performance reinforcing fibers.

Classification of Composites

The composites materials are classified based on the type of matrix material and the type of reinforcement used.

Based on type of matrix material

Polymer matrix composites (PMC)*:* The most common advanced composites are PMC. These composites consists of a polymer (e.g., epoxy, polyester, urethane) reinforced by thin diameter fibers (e.g., graphite, aramids, boron). The advantages are: low cost, high strength, and simple manufacturing principles and the drawbacks are: Low operating temperature, high coefficients of thermal and moisture expansion and low elastic properties.

Metal matrix composites (MMC)*:* The matrix materials are: Aluminum, Magnesium, Titanium and the fibers are: Carbon, Silicon carbide. Metals are mainly reinforced to increase elastic stiffness and strength, decrease large coefficient of thermal expansion and electrical conductivities. The disadvantages are: higher processing temperatures and densities.

Ceramic matrix composites (CMC):The matrix materials are:Alumina (Al2O3), Calcium alumino silicate and the fibers are: Carbon, Silicon carbide (SIC). The advantages are: high strength, hardness and high service temperate.

Based on Type of Reinforcement

Particle reinforced composites: These composites consist of particles immersed in matrices such as alloy and ceramics as shown in Fig. 3.1 . The shape of reinforcing particles may be spherical, cubic or any regular or irregular geometry. They are usually Isotropic, since particles are added randomly. These composites have improved strength, increased operating temperature and oxidation resistance.

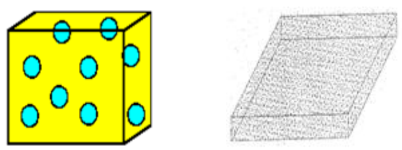

Fig Particle reinforced composites

Fiber reinforced composites*:* These composites consist of matrices reinforced by short (discontinuous) or long (continuous) fibers as shown in Fig. Generally these are anisotropic.

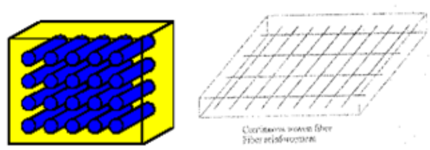

Fig Fiber reinforced composites

Advantages and Disadvantages of Synthetic Fiber Composites

The advantages are:

- Composites are having high strength to weight and stiffness to weight ratios.
- Composites can also have other attractive properties, such as fatigue and impact
- Resistance, corrosion resistance, high thermal or electrical conductivity, and a low coefficient of thermal expansion etc.
- We can lower the overall mass of material without losing its strength and stiffness.
- Another key factor for using the composites is metals and alloys can't always meet the required demands.
- Even if we increase the strength by alloying, but they can't withstand at higher temperatures as compared to composites because of their high coefficient of thermal expansion.

The disadvantagesare:

- Difficult to recycle.
- High production cost.
- Environmentally not safe.

Classification of Natural Fibers

Natural fibers include those made from plant, animal and mineral sources. Natural fibers can be classified according to their origin as shown in Fig.3.5

Fig Classification of natural fibers

Vegetable fibers: Vegetable fibers are generally comprised mainly of cellulose: examples include cotton, linen, jute, flax, ramie, sisal, and hemp. Cellulose fibers serve in the Manufacture of paper and cloth. This fiber can be further categorized into the following

Seed fiber: Fiberscollected from seeds or seed cases. e.g. cotton and kapok

Leaf fiber:Fibers collected from leaves. e.g. Sisal and agave.

Bast fiber or skin fiber:Fibers are collected from the skin or bast surrounding the stem of their respective plant. These fibers have higher tensile strength than other fibers. Therefore, these fibers are used for durable yarn, fabric, packaging, and paper. Some examples are jute, kenaf, industrial hemp, ramie, rattan, soybean fiber, and even vine fibers and banana fibers.

Fruit fiber:Fibers are collected from the fruit of the plant, e.g. coconut (coir) fiber.

Stalk fiber: Fibers are actually the stalks of the plant. e.g. straws of wheat, rice, barley, and other crops including bamboo and grass. Tree wood is also such a fiber.

The most used natural fibers are cotton, flax, and hemp, although sisal, jute, kenaf, and coconut are also widely used. Hemp fibers are mainly used for ropes and aero foils because of their high suppleness and resistance within an aggressive environment. Hemp fibers are, for example, currently used as a seal within the heating and sanitary industries.

Animal fibers: Animal fibers generally comprise proteins; examples include silk, wool, angora, mohair, and alpaca.

Animal hair (wool or hairs):fiber or wool taken from animals or hairy mammals. e.g. sheep's wool, goat hair (alpaca, Cashmere), horse hair, etc

Silk fiber:fiber collected from dried saliva of bugs or insects during the preparation of cocoons. Examples include silk from silk worms**.**

Avian fiber:fibers from birds, e.g. feathers and feather fiber.

Mineral fibers:Mineral fibers are naturally occurring fiber or slightly modified fiber procured from minerals. These can be categorized into the following categories.

Asbestos: The onlynaturally occurring mineral fiber. Variations are serpentine (chrysotile) and amphiboles (amosite, crocidolite, tremolite, actinolite, and anthophyllite).

Ceramic fibers: glass fibers (glass wool and quartz), aluminum oxide, silicon carbide, and boron carbide.

Metal fibers: aluminum fibers

Structure and Chemical Composition of Natural Fibers:

All plant species are built up of cells. When a cell is very long in relation to its width it is called a fiber. The components of natural fibers are cellulose, hemicelluloses, lignin, pectin, waxes and water-soluble substances. The cellulose, hemicelluloses and lignin are the basic components of natural fibers, governing the physical properties of the fibers. The principal chemical constituents of fibers from various plant fibers are shown below in Table3.1.

Table 3.1: Chemical Composition, Moisture Content, and Microfibrillar Angle of Vegetable fibers

Fiber	**Cellulose (Wt%)**	**Hemicellulose (Wt%)**	**Lignin (Wt%)**	**Pectin (Wt%)**	**Moisture (Wt%)**	**Waxes (Wt%)**	**Microfibrillar angle (deg)**
Flax	71	18.6-20.6	2.2	2.3	8-12	1.7	5-10
Hemp	70-74	17.9-22.4	3.7-5.7	0.9	6.2-12	0.8	2-6.2
Jute	61-71.5	13.6-20.4	12-13	0.2	12.5-13.7	0.5	8
Kenaf	45-57	21.5	8-13	3-5	-	-	-
Ramie	68.6-76.2	13.1-16.7	0.6-0.7	1.9	7.5-17	0.3	7.5
Nettle	86	-	-	-	11-17	-	-
Sisal	66-78	10-14	10-14	10	10-22	2	10-22
Henequen	77.6	4-8	13.1	-	-	-	-
PLAF	70-82	-	5-12.7	-	11.8	-	14
Banana	63-64	10	5	-	10-12	-	-
Abaca	56-63	-	12-13	1	5-10	-	-
Oil palm EFB	65	-	19	-	-	-	42
Oil palm mesocarp	60	-	11	-	-	-	46
Cotton	85-90	5.7	-	0-1	7.85-8.5	0.6	-
Cereal straw	38-45	15-31	12-20	8	-	-	-
Wood	45	23	27	-	-	-	-

Cellulose is resistant to strong alkali (17.5 wt %) but is easily hydrolyzed by acid to water-soluble sugars. Cellulose is relatively resistant to oxidizing agents. Hemicelluloses are polysaccharides composed of a combination of 5- and 6- ring carbon ring sugars. Hemicelluloses form the supportive matrix for cellulose microfiberils. Lignin is the compound that gives rigidity to the plants.

Properties of Natural Fibers:

Natural fibers have always found wide range of applications from the time they gained commercial recognition. Their versatility is based on the following desirable material properties.

- Plant fibers are a renewable raw material and their availability is more or less unlimited.
- Very good mechanical properties, especially tensile strength.
- Very good heat, acoustic and electrical insulating properties.
- Combustibility: products can be disposed of through burning at the end of their useful service lives and energy can simultaneously be generated.
- Biodegradability: as a result of their tendency to absorb water, natural fibers will biodegrade under certain circumstances through the actions of fungi and/or bacteria.
- The abrasive nature of natural fiber is much lower compared to that of glass fiber, which leads to advantages in regard to technical, material recycling or processing of composite materials in general.

The properties described above show that there should be an increasing role for Plant fiber based products in the future. The drawbacks of natural fibers are listed below:

- Lower strength properties, particularly its impact strength.
- Variability in quality, depending on unpredictable influences such as Weather or climatic conditions.
- Moisture absorption, which causes swelling of the fibers.
- Restricted maximum processing temperature.
- Lower durability, fiber treatments can improve this considerably.
- Poor fire resistance.
- Price can fluctuate depending on harvesting results.

Types of Resins

Thermoplastic Resins

Enthusiasm for thermoplastic composites is generated basically for three different reasons. First, processing can be faster since no curing reaction is required. Thermoplastic composites only require heating, shaping and cooling. Secondly, the properties are attractive, in particular, high delaminating resistance and damage tolerance, low moisture absorption and the excellent chemical resistance of semi crystalline polymers. Thirdly, they have very low toxicity since they do not contain reactive chemicals (therefore storage life is infinite). Because it is possible to re-melt and dissolve, their composites are also easily recycled or combined with other recycled materials. Commercially prepared tape such as CF/PEEK (carbon fiber/polyether ether ketone) and later CF/PPS (polyphenylenesulfide) was introduced in the early 1980s. PEEK and PPS have excellent chemical resistance and are superior to epoxy-based composites. However, as early as 1966, Menges reported on improved static strength and fatigue resistance when epoxy was replaced by polyamide as a composite matrix. In the mid**,** there was an interest in CF/PSU (polysulfone) due to expectations of better processing methods and improved toughness characteristics.

Thermo set resins

Thermo set materials are cross-linked polymers that are cured by applying heat or under Pressure. Cured thermo set resins may soften when heated but do not melt or flow. They generally offer higher resistance to heat than thermoplastic. Thermo set materials often contain filler material such as powder or fibers to improve the strength or stiffness. Thermo set provides a variety of features. Products that are designed for electrical and Electronic applications often provide protection against electrostatic discharge (ESD), Electromagnetic interference (EMI) or radio frequency interference. The most common thermo set resins used in preparation of composites are unsaturated polyesters, epoxies, vinyl esters and phonemics.

Unsaturated polyester resins

They represent approximately 75% of the total resins used in the composites industries. Thermo set polyesters are produced by condensation polymerization of di carboxylic acids and di functional alcohols (glycols). In additions unsaturated polyester contains unsaturated materials such as malefic anhydride or fumaric acid as part of the dicarboxylic acid components. Polyesters are considered as versatile due to their ability to be modified during the formation of polymer chains. Unsaturated polyesters are divided into classes depending upon the structure of their basic building blocks. For example orthophthalic, isophthalic and dicyclopentadiene are classified according to their structure. According to the end use application, polyester resins are classified into general purpose or specialty polyesters.

Epoxy resins

Epoxy resins are well widely used in a range of composite parts, structures and concrete Repairs. Major advantage of epoxy resins over polyester resins is mainly the lower Shrinkage. Epoxy resins can be formulated with different materials or blended with other Epoxy resins to attain specific features oriented performance. To match the process requirement their cure rates can be controlled by proper selection of hardeners or Catalysts. Curing of epoxies is normally done by using amine hardener or anhydride. Variety of hardeners and different quantity of hardeners can produce different cure Profile and give different properties to the resultant composites. Epoxies are used with number of different fibrous reinforcing materials including glass, Carbon, aramid and different natural fibers. Epoxies are well known their compatible with common composite manufacturing processes like autoclave molding, vacuum-bag molding, compression molding, pressure-bag molding, filament winding and hand Lay-up.

Vinyl ester resins

Vinyl ester resins were developed to obtain the advantages of epoxy resins along with better handling and faster cure, which are typical properties of unsaturated polyester Resins. Epoxy resins are reacted with acrylic or met acrylic acid to produce vinyl ester Resins. The resulting product is dissolved in styrene to obtain a liquid which have the Similarities to polyester resins. These resins are also cured with the conventional organic Peroxides. Enhanced properties such as mechanical toughness and excellent corrosion Resistance are achieved without any complex processing techniques, handling or special Fabricating methods which are common with epoxy resins.

Phenolic resins

Phenolic resins are a commonly based on phenol and formaldehyde. These are thermo setting resins and are cured by a condensation reaction. It produces water and it is necessary to remove water during processing. The application of such resins is limited to pigment to red, brown or black. Phenolic resins have low smoke, very low toxicity and the good fire retardant properties which are considered to be the predominant reasons for their increasing acceptance in all fire safety applications. Composites made of phenolic resins have many desirable performance qualities including high temperature resistance, creep resistance, excellent thermal insulation and sound damping properties. Phenolics have different applications as adhesives or matrix binders in plywood (Engineered wood), circuit boards, brake linings, clutch plates.

Manufacturing Methods

Pultrusion Process

Pultrusion is a continuous molding process that combines fiber reinforcement and thermosetting resins. The pultrusion process is used in the fabrication of composite parts that have a constant cross section profile such as ladder side. Rails, tool handles etc. Reinforcement materials such as roving mat or fabrics positioned in specific location using performing shapers or guides to form the profile. Reinforcements are drawn through a resin bath or wet out where the material is thoroughly coated or impregnated with a liquid thermosetting resin. The resin saturated Reinforcements enter a heated metal pultrusion die. Dimensions and shape of the die will define the finished part being fabricated.

Resin Transfer Moulding

Resin transfer molding is commonly referred to as closed-mold process in which reinforcement material is placed between two matching mold surfaces one being male and other being female. the matching mold set is then closed and clamped and a low viscosity thermo set resin is injected under moderate pressure (50-100 psi) into the cavity through a port or series of ports with in a mold. The resin is injected to fill all voids with in the mold set and thus penetrates and wets out all surfaces of the reinforcing materials.

Filament Winding

The filament winding process is used in the fabrication of tabular composite parts. Typical examples are composite pipe, electrical conduit and composite tanks.

Fiber glass roving strands are impregnated with a liquid thermosetting resin and wrapped onto a rotating mandrel in a specific pattern. When the winding operation is completed, the resin is cured or polymerized and a composite material is removed from the mandrel.

Hand Lay-Up

Hand lay-up techniques are best used in applications where production volume is low and other forms of productions would be prohibitive because of costs and size requirements.

Advantages and Applications of Natural Fiber Composites

Advantages of Natural Fiber Composites

- Availability from renewable sources
- can be thermally recycled (posses a good calorific value), biodegradable,
- Low energy consumption
- These are environmentally superior
- Give less problem concerning health and safety of workers
- Less abrasive and more pleasant to handle, give natural image
- Good specific properties
- Good mechanical, thermal and acoustic properties
- Excellent price-performance(often low cost)

Disadvantages

- Moisture Adsorption
- Fluctuation in quality, price and availability
- Dimension instability
- Susceptibility to rotting
- Swelling leads to micro-cracking
- Restricted processing temperature
- Low strength
- Smell of natural fibers when process at high temperature

Applications

Building Products:

- Decking
- Window/Door
- Fencing
- Decorative Trim
- Railings

Infrastructure:

- Boardwalks
- Bridge
- Guardrails

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Transportation:

- Interior Panels
- Shelves
- Ducting
- Truck Floor
- Head liners

Industrial/Consumer:

- Pallets
- Playground
- Benches/Tables
- Floorings
- Trash

Marine:

- Small fishing boats

Applications in Automobile field:

The likely future business opportunities in automotive sector are, PultrudedDriveshafts, RTM Panel, Rocker Arm Covers, Suspension Arms, Wheels and Engine Shrouds, Filament-Wound Fuel Tanks, Electrical Vehicle Body Components and Assembly Units. Current well- established applications of natural fibers in automotive vehicles shown in table. The schematic of a generic vehicle, made from natural fiber composite materials Figure 3.10

Table: Vehicle Manufacturers and use of Natural Fiber Composites

AUTOMOTIVE MANUFACTURER	MODEL APPLICATIONS
AUDI	A2, A3,A4 (& Avant), A6, A8, Roadster, Coupe Seat backs, side and back door panels, boot lining, hat rack, spare tyre lining
BMW	3,5,7 series Door panels, headliner panel, boot lining, seat backs, noise insulation panels, moulded foot well linings
FIAT	Punto, Brava, Marea, Alfa romeo 146, 156
FORD	Mondeo CD 162, Focus Door panels, B-pillar, boot liner
ROVER	2000 and other Insulation, rear storage shelf/panel
MERCEDES-BENZ	TRUCKS Internal engine cover, engine insulation, sun visor, interior insulation, bumper, wheel box, roof cover
VOLVO	C70, V70 Seat padding, natural foams, cargo floor tray
SEAT	Door panels, seat backs
TOYOTA	Brevis, Harrier, Celsior, Raum Door panels, seat backs, Spare tyre cover

Fig : Components on a generic vehicle, made from natural fiber composite materials

Fig Seat backs

Fig.bridge

Fig Railings

Fig Flooring

Fig Jute-pp suitcase (latex impregnation)

Details of plant fiber:

Hibiscus Lampas is an erect, slightly branched shrub 2-3 m in height. The leaves are ovate, 10-20 cm long, somewhat 3-lobed or nearly entire, green and nearly smooth on the upper surface, somewhat hairy beneath, broad and heart-shaped at the base and pointed at the tip. The flowers are large, and borne in threes in the apex of the branches or at the axils of the leaves. The calyx is green, with 5 pointed lobes united below the middle. The corolla is bell-shaped, 6-8 cm long, yellow, and dark-purple at the center. The capsules are ovoid, and about 3 cm long, with 4-5 valves. A weak rope is made from the bast of this plant.

Fig *Hibiscus lampas plants*

III. FABRICATION OF LAMINATES

Extraction of Fibers

Hibiscus Lampas:

Hibiscus Lampas is a moderate-sized to large tree, up to 24-30 m tall. Characteristically found in teak forests, dry savannah and degraded dry deciduous forests. The tree is distributed in isolated patches, varying in extent in the drier parts of the Indian peninsula.

Fodder: Leaves contain about 9% crude protein, but the amount varies with the age of the leaves. Fuel: H.lampas provides excellent firewood and good charcoal. Fiber: The stem yields a strong fiber largely employed for making ropes.

Hibiscus Lampas (ADAVI BENDA) plants are observed in the forest near to Mahabubabad. After cutting stem from the tree (in wet conditions), there are soked in water nearly one week after that we will hammering stem then stem will be a fiber. The entire process will be shown in below figures.

Fig Stems of Hibiscus lampas after cutting

Fig Soked in Water

Fig Fibers after hammering

Fig Cutting of Short Fibers

Preparation of Laminate

Glass Plate Surface Preparation

First Wax polish is applied on the surfaces of the base plates and poly vinyl alcohol (PVA) is applied with a brush and allowed to dry for few minutes to form a thin layer. These two items will help in easy removal of the laminate from the base plates. PVA also provides a glossy finish to the surfaces of the laminate. The isopthalic polyester resin is taken along with 2% each of catalyst-MEKP and accelerator- Cobalt napthalate. The weight of the resin is 41 times the weight of the fiber mat taken for the laminate. The catalyst initiates the polymerization process and the accelerator speeds up this process. Initially the catalyst is added and then the accelerator is added next. The contents are thoroughly stirred and then placed on the base surface and spread uniformly with the brush. The fiber mat is placed over the resin mix and then trolled with the roller to wet the mat uniformly and to remove the air entrapped. Further, quantity of resin is placed over the rolled mat and once again pressing is done by the roller for uniform distribution of the resin over the surface of the mat. It is always preferable to add lesser quantity of accelerator than the specified amount of accelerator to avoid solidification of the contents before they are applied over the surfaces. Then the top base plate that was already applied with the wax and PVA is placed on the laid resin and a weight of about 1000 N is placed over for about 24 hours.

Fig : Wax, PVA.

Fig :MEKP.

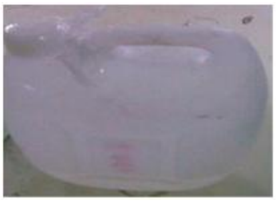

Fig : Accelerator.

Fig : Isopthalic Polyester resin

Figure : Surface Plate

4.3 Hand Lay Up Process

Fiber of required dimension is placed on the surface of above prepared mixture. Once again a mixture of resin, accelerator and catalyst are added proportionally and thoroughly mixed and laid upon the mat. Rollers are used to ensure the removal of entrapped air and uniform distribution of resin on the fiber. A weight is placed upon this. A typical hand lay-up process is shown in Fig. 4.6

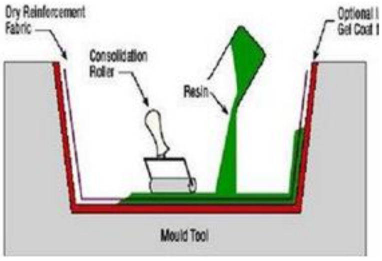

Fig Hand layup process

IV. SPECIMEN PREPARATION AND TESTING

Preparation of Specimens

Specimens for tensile test, flexure test, impact test and water absorption test as per ASTM standards are prepared. The dimensional details for each type of specimen are presented in respective diagrams.

5.1.1. Tensile Test Specimen

Specimens are cut from laminates on a jig saw machine as per ASTM D 638 Standards [7]. The dimensions of the tensile test specimens are shown in the Fig.5.2

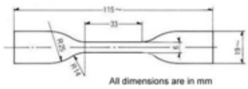

Fig Tensile Specimen

Water Absorption Test Specimen

Specimens for Water absorption test are cut from laminates as per ASTM D 570 standards [9]. The standard dimensions for test specimen are shown in the Fig5.7.

Fig Water Absorption Test Specimen

Fig Tensile Test Specimens of 3mm length fiber before Testing

Fig Tensile Test Specimens of 7 mm length fiber before Testing

Fig Tensile Test Specimens of 5 mm length fiber before Testing

Testing

Tension and flexural tests are conducted on the specimens to compare the strengths between *Hibiscus lampas* and glass fiber composites.

Tensile Test:

In a Randomly Oriented Composite subjected to increasing longitudinal tension load, failure initiates by fiber breakage at their weakest cross sections. Tensile test is conducted on universal testing machine. Load is gradually increased and deflection is observed on extensometer.

Fig Specimens of 3 mm length fiber after Testing

Fig Specimens of 7 mm length fiber after Testing

Fig Specimens of 5 mm length fiber after Testing

Adavibenda Randomly Oriented Fibers of 3 mm Length:

Specimen	Load (N)	Thickness (mm)	Width (mm)	Area (sq. mm)	Stress (N/sq. mm)	Strain
1	1381.8	4.4	8.5	37.4	36.9465	0.1869
2	947.66	4.4	9.0	39.6	23.9308	0.1000
3	1015.28	4.4	9.0	39.6	25.6384	
4	698.7401	4.4	6.5	28.6	24.4315	0.00913
5	526.26	4.0	6.5	26.0	20.2408	0.00652
					Mean stress = 26.2376	Mean strain= 0.01252

Adavibenda Randomly Oriented Fibers of 7 mm Length:

Specimen	Load (N)	Thickness (mm)	Width (mm)	Area (sq. mm)	Stress (N/sq. mm)	Strain
1	409.9245	2	8	16	25.6203	0.06956
2	653.0132	4	9.5	38	17.1846	0.05652
3	910.7141	4	6	24	37.9464	0.06956
					Mean stress = 26.9171	Mean strain= 0.06521

Adavibenda Randomly Oriented Fibers of 5 mm Length:

Specimen	Load (N)	Thickness (mm)	Width (mm)	Area (sq. mm)	Stress (N/sq. mm)	Strain
1	105.458	1.2	6	7.2	14.6469	0.03478
2	53.63	1.3	7	9.1	5.8941	0.02347
					Mean stress = 10.2705	Mean strain= 0.02912

Results for Tensile Test on 3mm length Hibiscus lampas Fiber Randomly Oriented specimens

Guage Length (L) = 115 mm

Cross section area of the specimen (*A*) = (width)x(thickness)=39.6mm^2

From Table 5.2.1: The Mean Stress at failure = *P* / *A* = 26.2376N / mm^2

Ultimate strength obtained = 36.9465N/ mm^2

Results for Tensile Test on 7mm length Hibiscus lampas Fiber Randomly Oriented specimens

Guage length (*L*) = 115 mm

Cross section area of the specimen (*A*) = 38mm^2

From Table 5.2.2 The Mean Stress at failure = *P* / *A* = 26.9171N / mm^2

Ultimate strength obtained = 37.9464 N/ mm^2

Results for Tensile Test on 5mm length Hibiscus lampas Fiber Randomly Oriented specimens

Guage length (*L*) = 115mm

Cross section area of the specimen (*A*) = 7.2mm^2

From Table 5.9: The Mean Stress at failure = *P* / *A* = 10.2705N/ mm^2

Ultimate strength obtained = 14.6469N/ mm^2

V. CONCLUSIONS AND SCOPE FOR FUTURE WORK

Stemsof Hibiscus Lampasplants are collectedfromMahabubabadforest and fibers extracted from the stem. Randomly Oriented single layered laminates are prepared using Isopthalic polyester resin supplied by Ecmas Resins Private Limited, Hyderabad. Fiber, matrix volume ratio of 1:41 is applied. 10 Standard test specimens are prepared for Randomly Oriented lamina of 3mm, 7mm, 5mm length fibers respectively as per ASTM standards. Tensile experiment is conducted. The observed test results are compared with available results in the literature. The specimens exhibited comparable values of, tensile strength with those available in the literature for similar situation. However, it is noticed that the material has exhibited extremely low impact resistance.

However, it can be suggested that higher values of the strength parameters can be obtained by taking a Randomly Oriented laminate of two or more layers instead of a single lamina with more strands of fibers of 7mm length. Further, it can be suggested to use Isopthalic Polyester resin to achieve superior mechanical properties and water resistance.

VI. REFERENCES

[1]. Thi-Thu-Loan Doan, Hanna Brodowsky, Edith Mader , Jute fibre/polypropylene Composites II: Thermal, hydrothermal and dynamic mechanical behavior, *Composites Science and Technology, 67* (2007), pp.2707–2714.

[2]. Elisa Zini , Maria Letizia Focarete , Isao Noda , Mariastella Scandola , Bio-composite of bacterial poly (3-hydroxybutyrate-co-3-hydroxyhexanoate) reinforced with vegetable fibers,*Composites Science and Technology,* 67 (2007), pp.2085–2094.

[3]. Exequtel Rodriguez, Roberto Petrucci, Debora Puglia, Jose M. Kenny and Analia Vazquez, Characterization of composites based on Natural & Glass fibres obtained by Vacuum infusion. *Journal of Composite Materials*, vol. 39, No. 3/2005: pp.265 – 281.

[4]. V. Alvarez, A. Vazquez, C.Bernal, Fracture behavior of sisal fiber reinforced starch

Based composites,*Polymer Composites*, 26: (2005): pp.316 - 323.

[5]. Elinton S.de medeiros, Jose A.M.Agnelli, Kuruvilla Joseph, Laura H.de carvatho,Luiz H.C.MattosoMechanical properties of phenolic composites reinforced with Jute/cotton hybrid Fabrics, Polymer *composites* -2005: pp 1 - 11

[6]. ASTM D 790 – 61, Standard method of test for Flexural properties of Plastics, American Society for Testing Materials (1961).

[7]. ASTM D638– 01, Standard test method for Tensile properties of Plastics, American Society for Testing Materials (2001)

[8]. ASTM D 256 – 56, Standard methods of test for Impact Resistance of Plastics And Electrical Insulating Materials American Society for Testing Materials (1956)

[9]. ASTM D 570 – 59a T, Standard methods of test for Water absorption of Plastics , American Society for Testing Materials (1959)

[10]. www.apforest.nic..in

[11]. MahmoodulHaq , RigobertoBurgueño, Amar K. Mohanty, ManjusriMisra, Hybrid bio-based composites from blends of unsaturated polyester and soybean oil reinforced with nanoclay and natural fibers. *Composites Science and Technology* 68 (2008), pp 3344–3351.

[12]. A. K. Mohanty, P. Tummala, W. Liu, M. Misra, P. V. Mulukutla, and L. T. Drzal, Injection Molded Biocomposites from Soy Protein Based Bioplastic and Short Industrial Hemp Fiber. *Journal of Polymers and the Environment*, Vol. 13, No. 3, July 2005, pp 279 – 285.

[13]. Craig Clemons, Anand R. Sanadi, Instrumented Impact Testing of Kenaf Fiber Reinforced Polypropylene Composites: Effects of Temperature and Composition. *Journal of Reinforced Plastics and Composites*, Vol. 26, No. 15/2007, pp 1587–1602.

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